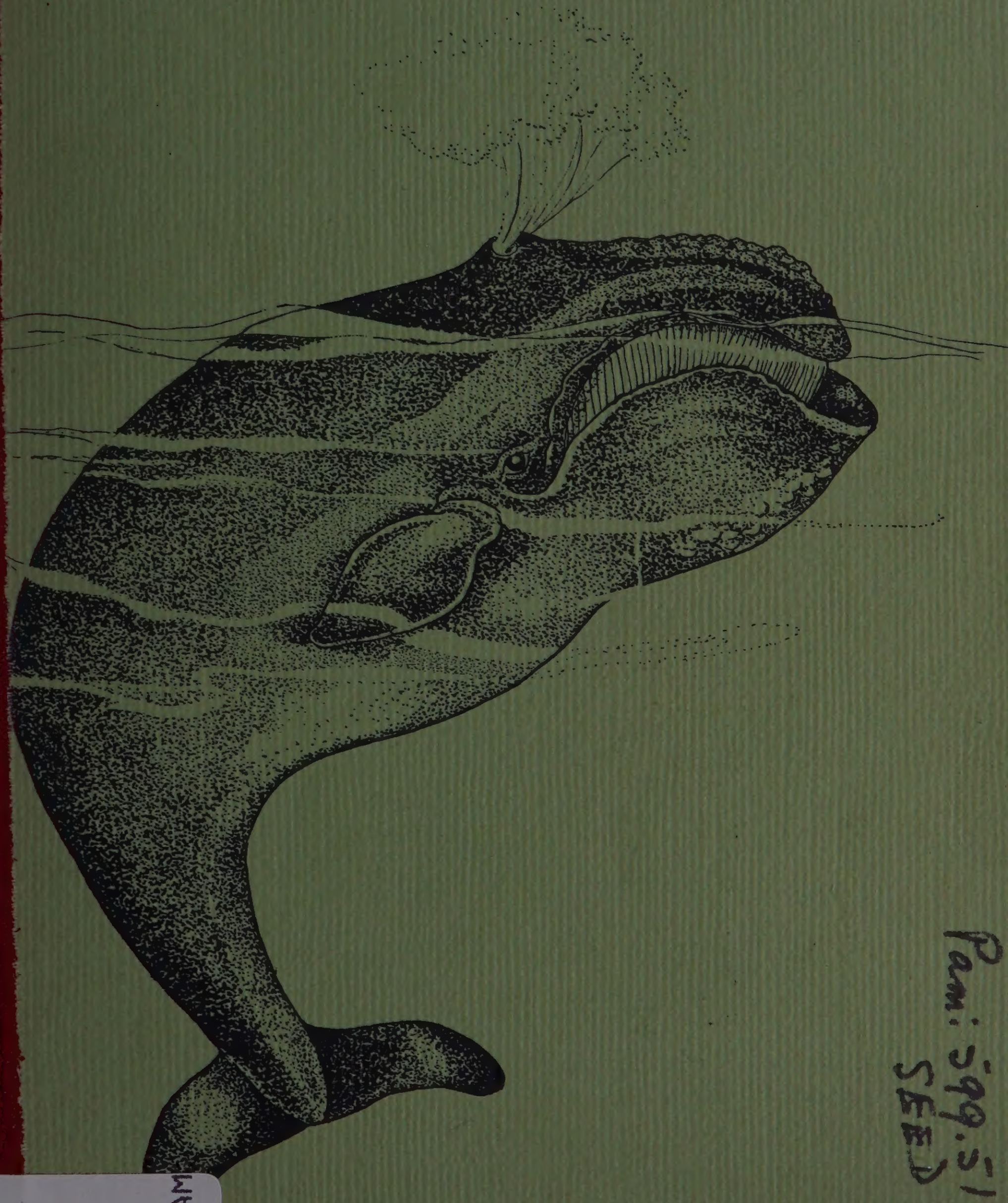
BALEEN

WHALES

IN EASTERN NORTH PACIFIC AND ARCTIC WATERS



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BALEEN

WHALES

IN EASTERN NORTH PACIFIC AND ARCTIC WATERS

Compiled by Alice Seed
Cover sketch and drawings by Maxine Morse

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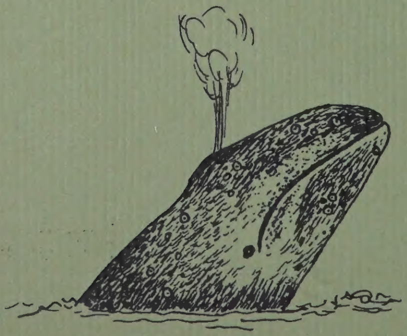

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INTRODUCTION

Alice Seed

For centuries whales by their very size, unusual habits, and the ingenious methods by which they are caught have captured man's imagination. Scientists are curious to know how this mammal adapts so perfectly to its unusual environment - water.

Cetaceans (the general name for whales, dolphins, and porpoises), are entirely aquatic, and the larger species are the largest known animals, living or fossil, ranging in size from 4.3 feet and 65 pounds to over 100 feet and one third million pounds. They are warm-blooded creatures, breathe air, and suckle their young. The origin of whales is unknown other than that they are placental mammals. Their ancestors have been traced in fossil records to the beginning of the Age of Mammals. Through evolution over a long period, striking physical and physiological changes occurred that enabled them to adapt to a watery environment.

Possibly at some point in time there was a basic separation into three distinct lines — the toothed whales, *Odontoceti;* the baleen, or whalebone, whales, *Mysticeti;* and the extinct zeuglodonts, *Archaeoceti* — all customarily ranked as suborders under the single order *Cetacea.* However, today many are favoring ordinal rank for each group, and the possibility of polyphyletic origin and convergent evolution has not been disproven.

Our first booklet was about the toothed whales; this collection of articles is about the order *Mysticeti,* in particular the baleen whales found in the eastern North Pacific and arctic waters. The following three families are represented: *Balaenidae, Eschrichtiidae,* and *Balaenopteridae.*

There is evidence of man's age-long hunt for the whale for both food and valuable products during the Stone Age. Drawings scratched on rocks by primitive man in 2200 B.C. show that he was well acquainted with cetaceans. Bones from Eskimo middens indicate whale hunting in 1500 B.C. The ancient Greeks used the whale motif on vases, coins, and buildings. Aristotle thought the *Mysticetus* had "pig's bristles" for teeth - undoubtedly referring to the hairy fringe at the inner side of the baleen of the whale.

Highly adapted to life in the water, cetaceans have fish-like bodies with forelimbs modified as paddle-shaped flippers, no external hind limbs, and a powerful tail that has horizontal flukes at the tip. The body is essentially hairless, although some tactile hairs persist on the forward part of the body. A thick insulating layer of blubber, or fat, just under the outer skin maintains the body heat. The baleen whale has a symmetrical skull, and a pair of nostrils, called blowholes, that open on the top of the head in two longitudinal slits, through which it breathes air when it surfaces.

The whalebone whale fetus has tooth buds, but these are resorbed by the time of birth. Each side of the palate carries a series of horny plates (baleen or whalebone) suspended side by side from the roof of the mouth. Each plate is fringed into coarse "hairs", and all the fringes together form two sieve-like surfaces used to collect the small fish and plankton which form the usual diet of the baleen whale — a filter feeder.

Both the age at which baleen whales attain sexual maturity and the length of the gestation period vary, but breech (tail first) presentation is considered normal, and birth occurs in the water. The single newborn is precocial as it must be able to swim at birth, and it is suckled.

Cetaceans are the swiftest animals in the ocean; the large rorquals can attain speeds of about 23 mph for short periods. Most whales' eyes are well adapted for underwater vision, but they can see well above water too. Baleen whales are known to produce a variety of screams and moans — the function of these sounds is undoubtedly communicative or echo-ranging. There is much to be learned about their "language", which is currently being studied.

The long history of hunting this valuable baleen whale indicates that the early hunters utilized the whole whale; later, interest centered more exclusively on just the whale oil and baleen, and then on only the baleen. At present, the most valuable part of the whale is its meat. Over a period of time heavy commercial exploitation of the whale rapidly depleted the various species, which are now protected under international agreement. The International Whaling Commission is attempting to put harvests on a national basis, and is taking increased responsibility for whale conservation.

Knowledge of these cetaceans is limited in many ways due mainly to the difficulty of conducting research. Some studies center around the factory ships where biologists can make anatomical observations as the carcasses are flensed and butchered. Marked darts shot into the whale enable scientists to obtain records of their migration, growth, and age. Electronic methodology will permit long range studies. Research continues on this mammal's structure, biology, behavior, and remarkable adaptation to water.

The editor wishes to thank those who have so generously contributed articles, several of which appeared in *Pacific Search,* photographs, and art work that have made this booklet possible.

Eskimos launching the whale boat — Cape Prince of Wales. Photo by Edward S. Curtis, 1928.

HISTORY OF BOWHEAD WHALING

Floyd E. Durham

To some people, the whale is Melville's Moby Dick — the mythical, diabolical sperm whale of 1851. To others, the whale is Gigi — the angelical gray whale, pet of Sea World, southern California, of 1971-72. But to early coastal inhabitants of Europe, the whale was *Balaena mysticetus,* variously called Greenland whale, ice whale, or bowhead whale. This whale belongs to the group of whales called right whales — meaning right for small-town, poorly-equipped, open boat whalers to take. The whale is slow and timid, and the carcass floats. It yields the greatest amount of oil and has the longest, most numerous, supple baleen plates. With this combination of physical, behavioral, and economic characteristics, it is no wonder that it was probably the first great whale to be harvested for food by primitive man, and chief among the first great whales taken by commercial whalers.

Our knowledge of early aborigines' whaling comes largely from paintings on walls of caves, artifacts, and legends. Whaling cultures sprang up over the world. It appears that the Dorset and Thule cultures of Eskimos in the Arctic did better than just survive — they flourished. Probably their impact on the whale at that time was negligible. Their stone age tools were barely adequate for taking these whales; they killed mostly small, non-breeding individuals, utilizing all the animal. The whale was the symbol of the Great Spirit, the coming of spring, the beginning of feasting. This happy coexistence of man and the whale might have continued indefinitely; because he took only a few whales for his own use, the whale was not hurt.

The tempo of the chase quickened as whale products became better known and widely used. Coastal villagers whaled for inland neighbors. Some of the early civilized people not only ate whale flesh, but considered it a kingly delicacy. However, the prime commercial products over the early years were whale oil, mostly from the blubber, and whalebone — baleen — from the whale's straining basket. Industrious men needed whale oil for illumination, and stylish women needed whalebone for corsets and hoop skirts. Of course, other items were made from these whales. The European demand for oil and "bone" were largely supplied by the bowhead fishery in the Spitsbergen area east of Greenland. The Basque whalers of Spain improved on the skinboats and the flint-headed harpoons of the aborigines as they hunted the local Biscay right whale. These professional whalers were in great demand by the several maritime European nations that fitted out for a share of the bowhead loot.

In 1610, when whaling began east of Greenland, all whaling operations were land based. "Blubber-town", a model city of that age, complete from theater to graveyard, was built on Spitsbergen. By 1630, the whales near the island had been killed off, so fishing was extended to the west ice near Greenland's eastern shore. With the development of the oceangoing factory ship with "tryworks" on deck, whalers were able to operate independently of land, except for their home port. So within 50 years of the discovery of the east Greenland herd, it was exterminated and the hunting grounds abandoned. About 1660, the whalers focused on Davis Strait and Baffin Bay, named earlier from explorers searching for the Northwest Passage to India. Although the passage was not found, European whaling fleets pushed into these forbidding waters, first as far as Disco Bay, and later into the north water near Thule, Greenland, and finally into the west water off Canada.

Meanwhile the American colonies started whaling, first operating from shore stations in the 17th century, and later with an impressive whaling fleet of up to 750 vessels that searched the oceans of the world for whales. Besides operating northward in Greenland waters, they went southward, rounded Cape Horn, and searched the great Pacific where they took many sperm and right whales. Eventually they struck it rich in the North Pacific, where they discovered and dispatched, all in the 1840s, the herd of bowheads in the Okhotsk Sea. In 1848 a Yankee whaler passed through the Bering Strait, and found bowheads in countless numbers in the Arctic Ocean. Thus began the extermination of the fourth and last herd of bowheads.

The dauntless Yankee whalers endured all hardships of ice, cold, and isolation for the prized bowhead. The baleen from one large whale would pay for a one-year voyage, the blubber for a second year at sea. One good whaling season would pay for the ship or make up for six poor seasons, when the ship went home "clean" and empty. The Yankees in the Arctic supplied much of the world's demand for whale oil for lubricants, cosmetics, and candles. A large bowhead produced as much as 30 tons of oil, and up to a ton of whalebone. After the blubber had been spirally unwound from the dead whale alongside the ship, and the rostrum of the skull with the baleen attached had been hoisted aboard, the carcass of the whale was cut loose as worthless. The blubber was cut into small pieces and "tried" out on deck – fat rendered by heating in great rendering kettles. Because of the fire hazard of the furnace in rough seas, the blubber slabs were often taken back to New England for processing – another long and hazardous trip around the Horn.

The coming of the railroad was a boon to the Yankee whalers. When the Union Pacific extended its tracks westward from Omaha to meet the Central Pacific running eastward from San Francisco, the first transcontinental railroad was completed at Ogden, Utah in 1869. Many whalers based their ships in San Francisco, and shipped their whale products east by rail. Not only did the whalers spend less time "commuting", but whaling ships powered by steam engines were proving more efficient than sailing vessels in bucking through the ice jams in the Arctic. Coal for these external combustion engines was available in several places along the Alaskan coast at no cost to the whalers. Thus the pursuit of the whale intensified.

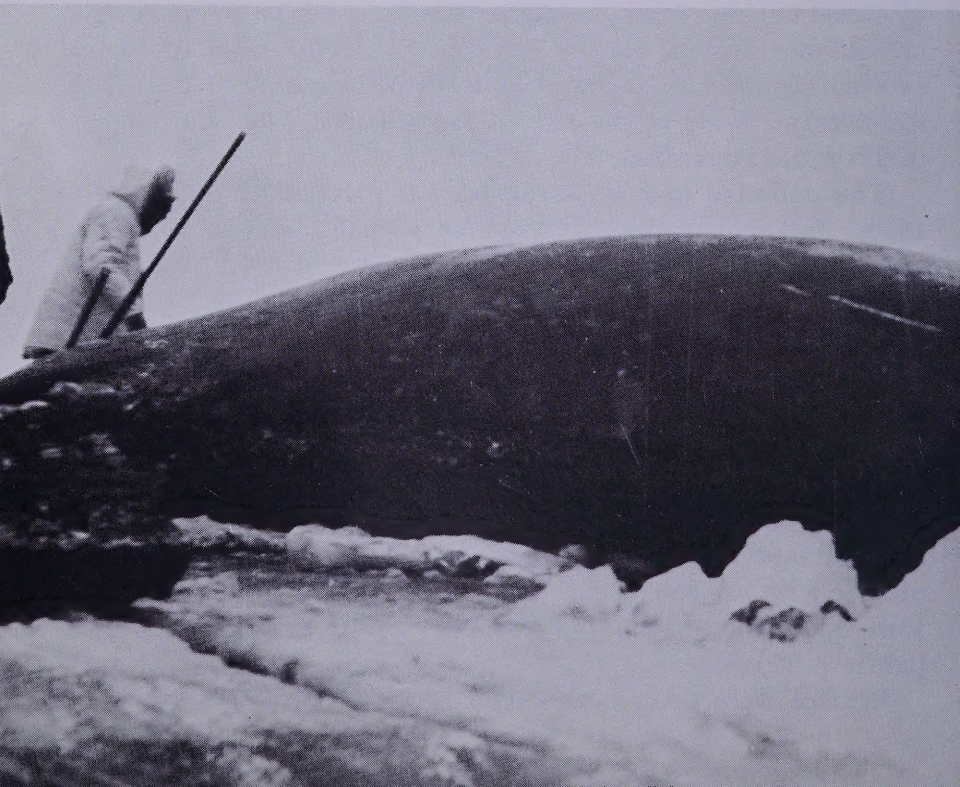
The potential fuel in petroleum was recognized in the early 1860s. Although surface deposits of asphalt, bituminous lakes, and "eternal fires" of escaping natural gas had been known for thousands of years, little use had been made of these solids, liquids, and gases. However, the first oil well was drilled in 1859; the first product, kerosene, was made by simple fractional distillation. Kerosene, when burned in lamps, illuminated better than candles. Cracking of petroleum later resulted in more volatile fuels, such as gasoline, which made the internal combustion engine possible. The new machine age of the late 19th century required lubricants as well as fuel, both more readily and cheaply obtained from petroleum than from whales. Parodoxically, lowered demand and price for whale oil only accelerated, rather than slowed, the slaughter.

Whales were sought no longer for blubber, but for baleen.

By 1904, only the sustained demand for baleen kept the whaling business going. The blubber was barely worth collecting, rendering, and freighting, so it became an optional commodity. If seas were rough, men tired, or holds nearly full, only the baleen was saved and the rest of the huge carcass was cut loose. This meant that more whales were killed before the ship was loaded to capacity. By whalers taking only the fully mature whales with 10-12 foot long baleen, each kill netted some 2000 pounds of baleen, which brought six dollars per pound.

The greater power and range of the steamship over the sailing ship, led to the discovery of the numerous whales of the Beaufort Sea in 1889. In 1890, two ships wintered in the Arctic for the first time. Thereafter, for the duration of the whaling, many ships took shelter behind Herschel and Baille Islands each winter, thus saving a 10,000 mile round trip to San Francisco, or a 30,000 mile round trip back to Nantucket. The whalers did not even eat the whale flesh, as the Eskimos did at every opportunity, but hunted the musk ox and caribou herds within 150 miles of the coast.

The early commercial whalers were wasteful. In most of the whaling countries, the great loin and tail muscles were not acceptable for human food. Even if they were, the early whalers



could not preserve the whale meat at sea without refrigeration and canning equipment. Thus about 20 percent of the total weight of the whale, or 10 tons of lean steak per large whale, was wasted. When whale oil was replaced by petroleum products, some 40 percent of the total weight — or 20 tons of blubber per large whale — was cast off with many of the carcasses in the last decade of whaling. This final stage of whaling was particularly wasteful — only the baleen was collected, about two percent of the weight of a whale. This kind of harvesting was particularly devastating to the whale stock because only large, breeding whales with very long baleen were worth taking.

What really saved the whale was the inventions of plastics; it struck at the baleen market. By 1908, when several light, flexible materials were produced from synthetic resins, baleen dropped to two dollars per pound. A few ships went to the Arctic in 1909 and 1910; they saw few whales, their catch was meager, and the voyages were failures. The Yankee whalers abandoned the Arctic.

There is now a sizeable herd of bowhead whales in the western Arctic. Thus, with the advance of civilization, the whale was saved by the mechanized arm of man, industrialization, which arm had threatened to destroy it during the 300 years before.

A young bowhead taken near Point Barrow, Alaska, shows its blowhole, curved, shallow upper jaw, and huge lower lip — both on the right side of the photo. Photo by author.

GREENLAND or BOWHEAD WHALE

Floyd E. Durham

Since 1596 modern man has known the Greenland whale, *Balaena mysticetus,* the bulwark of Eskimo and Norse whale cultures in Siberia, Alaska, and Greenland since 2500 B.C. Before that, according to the meager fossil record of marine mammals, whales populated the oceans since Miocene geologic time.

The whales knew but few barriers in their watery world. Continents could be skirted. Food ranged from near microscopic surface plankton to gigantic invertebrates at half-mile depths. If food dwindled seasonally in one area the whales frequently moved, often to polar regions, to richer "pastures", thus developing annual migratory patterns. Alternating with migration for feeding, were their retreats, usually to sheltered, warmer regions, for bringing forth young. Thus the responses of whales to their environment became a natural and rhythmic part of life in the ocean.

The several stocks of whales in the Tertiary adapted to all the variations found in oceanic living, except to abrupt changes in temperature. With the chilling of the seas in the latter part of the period, and successively in the following Pleistocene, all the warm-water-loving, equatorial species of whales were killed. Hence the whales of the world were divided into Northern Hemisphere and Southern Hemisphere stocks, with little or no mixing between them. Only minor racial differences occur now among whales that are hemispheres apart.

The scheme of world-wide distribution of whales in broad, latitudinal bands, or better yet in isothermal bands, took a new aspect in the Arctic. In this nearly landlocked ocean of omnipresent ice, three genera of whales developed — the Greenland whale, the belukha (beluga) whale, and the narwhal. When the

Eskimos eventually arrived at the rim of the Arctic Ocean they found these three whales in great numbers. On this almost unlimited supply of food, they built their coastal whaling cultures.

Nowhere else in the world were the whales obliged to feed, breed, and bring forth young in seas locked solid with ice packs or churning with ice floes. Precocial young slid down mother's vaginal ramp "feet first" from a uterine temperature of near 96 degrees F to an icy sea some 70 degrees colder. Until the calf could endure long submergences, it survived in the lee shelter of the mother's bulk. All this occurred with the herd in motion, bucking currents jammed with floes and retreating ahead of ice packs too thick to break through, and too extensive to risk submarining under, specially with a calf that still had to spend half its time at the surface. Northward migration and feeding of the herd in summer largely stopped at the ice pack (some 80 degrees N latitude), and southward migration generally extended into only the upper North Atlantic and into the Bering Sea. It was in the former that historic man get his first taste of the Greenland whale. He had been familiar with the Atlantic right whale, warm-water cousin of the Greenland whale, for 200 years. Because the ranges of these two whales met and occasionally overlapped seasonally near northern Scandinavia, Iceland, and Labrador, the two genera were systematically confused, of little concern to the whaler and to his eager whale customers.

The Greenland whale was found to have the longest, finest baleen, the thickest blubber, the head one-third the total length, the fewest whale lice, no barnacles, and no "bonnet", or warty mass, on the rostrum. Thus the Greenland whale became the most specialized of all the baleen whales. It adapted to the cold water by laying on an extra thick blanket of blubber, inadvertently increasing its commercial value. It adapted to seasonal geographic food shortages by developing the largest cavernous mouth of the animal kingdom, so that food might be taken whenever and wherever available. This whale is the only one that expanded its mouth dorsally in a high arched or "bow-shaped" rostrum that made the good Yankee synonym "bowhead" appropriate and popular, at least in the western world.

To provide a strainer for this large mouth, some 600 baleen plates, each up to 13 feet long, hang like latticed curtains from the upper jaw. Baleen plates from a large whale weigh a ton, and laid end-to-end stretch a mile. The huge mouth for obtaining food, and the thick insulating blanket, which also lessens the blows and buffeting of ice, are the chief characteristics enabling the Greenland whale to survive the rigors of the arctic environment. Absence of the dorsal fin is no handicap to this slow-swimming, bulbous whale, but is actually an advantage in navigating under the ice, and in opening breathing holes by battering its way through a foot or more of ice.

At the first danger signal, this timid whale instinctively retreats under the ice. Except for man, it scarcely has an enemy other than a shark or occasional pack of killer whales, near the southern limit of its range. In the open water the Greenland whale has but little defense against predators even with the mighty sweeps of its flukes "from eye to eye." At its fastest clip it could be overtaken by whale boats under sail or oars. When dead, the whale almost invariably floats because of its high blubber content and porous bones. This buoyancy was of great help to the few daring men in small boats who, through the ages, have handled bowhead whales up to 50 tons, often in high seas. Little wonder that this whale with its near relatives became the "right whales" to hunt!

The Greenland whale even looks appetizing to those people who eat its flesh. It has no barnacles and only an occasional whale louse. While feeding, it avoids carrion. It is too slow to eat fish, and those accidentally taken into the mouth can escape between the two "sides of baleen" which do not meet in the front of the mouth. By avoiding fish, the larger crustaceans, and mollusks, the whale avoids the secondary hosts of most of the internal parasites common to marine mammals.

Some of these survival characteristics are picturesquely recorded by early European observers. On the fatness of the animal, one commented, "A rope drawn to its (the whale's) full length can only just encompass its body where thickest." Regarding the long baleen, which mustache-like sometimes gets in the way, "Its mouth it cannot well open, for the whalebone sitting in its mouth are raised across the mouth when it is wide open, so that it often dies because it cannot shut its mouth again." On its clean habits and assumed diet, ".... the fish (whale) is very cleanly in its manner of living, for it is said not to take any other food than the fog and rain.... and though it is caught and its bowels opened, yet nothing unclean can be found in its stomach....which is clean and empty."

Because of the tragic experiences of whalers with sperm whales, the early whalers thought that the Greenland whale with such a big mouth was not only a "man-eater" but possibly a "boat-eater." Seeing the enormous tugboat-like whale pushing its gaping seining basket, half exposed, along the surface made the Eskimos fear that their umiak and whaling crew might be engulfed in the mouth of the whale. Such a disaster would dwarf the Jonah story. Obviously no man could be swallowed because the gullet of the Greenland whale is designed for plankton, and would probably pass nothing larger than a man's fist.

In spite of the nearly perfect adaptation by the bowhead whale to the arctic climate, there were times when the ice became so heavy that the whales were kept from their feeding grounds and were even suffocated, crushed, or buried beneath the pack. At such times the environment also ceased to be the friendly Arctic for man. Those staunch Yankee whaling ships of oak and steel that year after year fearlessly bucked the ice in the western Arctic, were sometimes overwhelmed by the ice, as in 1871, when 36 of the 41 vessels were crushed at anchor. The cyclic mood of the Arctic, with its fluctuations of temperature, precipitation, winds, and currents is best known in the Greenland area where a succession of Eskimo and Norse cultures, which sprang up in years when game was plentiful, died out completely, or moved, when food ran out.

From 1600 to 1910 there were five known drift ice advances at about 60 year intervals which affected the European Greenland whale fishery. When the ice did not break up in early spring but held firm all summer, it prevented the wintering whales from going north to their preferred feeding grounds in the Greenland Sea. Like salmon at the foot of an impassable dam, the whales were forced to remain along the southern edge of the compact ice where they were easily killed in great numbers by the commercial whalers. The leanness of these whales, as shown by the yield of whale oil at the various stages of the drift ice cycle, may have been the basis of the old story of the whales feeding on only "fog and rain" — hardly a nourishing diet. Starvation is one of the chief causes of infertility in animals, and this condition was probably as great a factor as overkill in the progressive decline, and finally the extinction of tribe after tribe of Greenland whales. As Greenland whaling became poorer and poorer, whalers rarely saw a female with a calf; there were but few yearlings, no large whales, and nearly all of those taken bore old harpoon wounds.

In light of archeological evidence and the short whaling record from the western Arctic, this same drift ice cycle probably occurred off the Alaskan coast. The cycle was probably in the concluding melting phase in the mid 19th century when commercial whaling began. The greatest harvest of baleen and oil was in 1853 and 1854. Thereafter the ice increased and the whale catch decreased, until 1910 when commercial whaling ceased because of the substitutes for whale products.

There are subcycles in these great 60 year ice cycles of the Arctic with unpredictable variations along the way. For example, in the summer of 1968 the ice retreated 150 miles (rather than 50 miles) northward off Point Barrow and remained offshore until December (not mid October), so that the southwestward migrating whales were so scattered and so far beyond the reach of the shore-based Eskimo whalers that none were caught. Whereas the following year, the ice never left shore from spring to fall, so no lead — the stretch of open water between the stationary shore ice resting on the bottom and the pelagic pack ice that drifts to and fro — formed, and no whales were taken or even seen. Because of capricious winds and possible currents, the drift ice seemed to complete its full cycle in two years.

The Greenland whale is a successful species. It is the one great whale to dominate a polar sea. Although other whales can endure the cold water seasonally, while actively swimming and feeding, the Greenland whale spends its entire year and reproductive cycle in the immediate vicinity of the ice. Because of its specialized food gathering, insulating, locomotive, and orientation characteristics, its powers of reproduction offset the hazards of its environment. It seems nearly free of disease, parasites, predators, and infant mortality which beset whales and animal life in general. The threat and toll of the normal Arctic with its vast, impenetrable ice fields, crashing icebergs, and grinding currents are tolerated by this whale. The catch by prehistoric man was negligible.

Since the beginning of life on earth, climatic variations, when too severe, have exterminated, on land and in the sea, plants and animals that were too slow to change. The drift ice advances were of insufficient frequency, intensity, and duration to start the decline of the successful, versatile Greenland whale. It was only when the commercial whalers threw their weight into the ring, along with that of the mighty periodic ice advances that the down count against tribe after tribe of the Greenland whale began.

GRAY WHALE

Dale W. Rice

The annual migration of the gray whale *(Eschrichtius robustus)* along the west coast of North America is one of the world's outstanding wildlife spectacles. From December through January these huge marine mammals may be seen from almost any headland or point along our west coast. They swim steadily southward, maintaining a speed of about five knots day and night. They usually surface and "blow" about four or five times during the space of a minute, and then dive and remain submerged for about four minutes. Single animals and pods of two or three are usually seen, but sometimes more than a dozen may travel together. Most of them pass within a mile of the beach — sometimes at the very edge of the kelp beds. However, when crossing long bights and indentations of the coastline, such as southern California below Point Conception, they may take a shortcut and pass far offshore.

From certain ideal lookout points, such as Yankee Point south of Monterey, California, as many as 200 whales may pass in a single day between sunrise and sunset during the middle of January. From late February to early May, they are again seen, this time heading north. In traveling between their summer grounds in the Bering Sea and Arctic Ocean and their winter grounds along the coast of Mexico, the gray whales may cover 10,000 miles in a year, the longest migration undertaken by any mammal.

Another population of gray whales lives in the western North Pacific, migrating between summer grounds in the northern Okhotsk Sea and winter grounds along the southern shores of Korea. Little has been learned of this population since the early 1930s, and it is believed to be nearly extinct. Sub-fossil bones dug from peat beds in Holland, England, and Sweden reveal that gray whales lived in the eastern North Atlantic until A.D. 500. The reason for their extinction there is unknown.

The gray whale is a baleen, or whalebone, whale -- a member of the Order *Mysticeti*. It is virtually a living fossil, and is similar to the extinct whales called *cetotheres* that lived from the middle Oligocene to the early Pliocene epochs, 30 million to 10 million years ago.

At sea, gray whales are readily recognized by their mottled gray color and lack of a dorsal fin. Instead of a dorsal fin, they have a low hump, followed by a series of 10 or 12 knobs along the dorsal ridge of the tail stock, which are readily seen as the animal arches to dive. The upper jaw is moderately narrow and arched. There are two or three grooves on the throat that presumably allow it to expand when the animal is swallowing. The flippers are large and paddle-shaped, and the tail flukes are broad. Adult gray whales are 36 to 50 feet long, and weigh from 16 to 45 tons.

Gray whales spend the summer in the shallow waters of the northern and western Bering Sea and in the adjacent waters of the Arctic Ocean. Some go as far east as Barter Island on the arctic coast of Alaska and as far west as Wrangel Island off the north coast of Siberia. Some are seen among the drifting floes of the pack ice. Summer is their feeding season. Their unique

Drawing by Evelyn Sczuck.

feeding habits explain why they remain in relatively shallow water. Unlike the other baleen whales, they are bottom feeders. Apparently, they plow up the soft sandy and silty bottom sediments with their snouts to stir up the small invertebrates that live there. These they filter from the turbid water with the course-fringed baleen plates (whalebone) that grow in a row along each side of their upper jaw. Their main food is amphipods — crustaceans one-third to one inch long related to sandfleas. In October, the Arctic seas begin to freeze, so the gray whales — fat after a summer of heavy feeding — begin their long southward migration.

About Christmas, the first gray whales arrive on the winter grounds along the west coast of Baja California. A few go around Cape San Lucas into the southern end of the Gulf of California. Here they find warm, calm waters, but little if any food. By the time they head north again in February and March they have lost 20 to 30 percent of their body weight and are so thin that they bear little resemblance to the plump animals that headed south the previous autumn. By the time they reach the northern feeding grounds again, they have fasted for almost six months.

The breeding season is mostly limited to a three-week period in late November and early December while the gray whales are on their southward migrations, although a few females may be

bred as late as the end of January on the winter grounds. Each female usually breeds once every two years. During the following summer, the pregnant females put on 25 percent more weight than the non-pregnant animals. The calf is born in the winter after a gestation period of about 13 months. Females about to give birth resort to certain shallow, protected lagoons in Baja California. The most famous of these is Laguna Ojo de Liebre, often called Scammon's Lagoon. The other major calving areas are farther south in Laguna San Ignacio and in Bahia Magdalena and adjacent waters. A few females give birth each year on the eastern side of the Gulf of California, along the coasts of Sonora and Sinaloa. At birth, the calf is 16 feet long and weighs close to 1000 pounds.

The mother's rich milk — over 50 percent fat — nourishes the calf for several weeks on the winter grounds and during the long migration to the summer grounds. The calf grows rapidly and by August, when it is weaned, it has attained a length of 28 feet. During its remaining two or three months on the summer grounds, it feeds heavily, and by the time it heads south in the late autumn it is about 30 feet long.

Both male and female attain sexual maturity at an age of five to 11 years, usually eight years. At this time, males average 36 feet long, females 38 feet. Gray whales may live to be over 50 years old.

The only predator that is a possible threat to the gray whale is the killer whale *(Orcinus orca).* Schools of killer whales have been seen attacking gray whales — usually unsuccessfully, although they have managed to kill a few calves. Many gray whales bear the tooth marks of killer whales on their flippers and flukes. The position of these scars suggests that killer whales attempt to catch gray whales by immobilizing them, so that they cannot come to the surface and breathe. However, it is doubtful if killer whales are capable of killing a healthy adult gray whale.

On their skin, all gray whales carry many large clusters of a unique parasitic barnacle *(Cryptolepas rhachianecti).* They are also infested with thousands of parasitic amphipod crustaceans called "whale lice" belonging to three species of the genus *Cyamus,* two of which are unique to the gray whale. Internal parasites are not common, but include tapeworms and thorny-headed worms in the intestine, roundworms in the stomach, and flukes in the intestine and liver.

The Nootka, Makah, Quillayute, and Quinault Indians, who lived on the Olympic Peninsula and Vancouver Island, were long renowned for their whale hunting ability. Ancient middens excavated at La Push, Washington, have yielded the bones of gray whales. The Indians chased the whales in large dugout canoes and struck them with harpoons attached to a line and float. The Indians still hunted whales as late as 1928 on the Washington coast.

The Eskimos of arctic Alaska and the Chukchi of eastern Siberia also hunted whales for thousands of years and still do. In aboriginal times, they chased the whales in frail skin-covered boats called umiaks, and killed them with ivory or bone tipped harpoons. After contact with American whalers in the late 19th century, they adopted the darting-gun and bomb-lance in place of the harpoon, but they still use the umiaks — the only practical kind of boat to use in the ice.

During the middle of the 19th century, American whalers from New Bedford and other east coast ports, who were scouring the globe in search of sperm whales *(Physeter catodon)* and right whales *(Balaena glacialis),* discovered the gray whales in the North Pacific. Concentrated in their calving lagoons, the gray whales were easy prey to the whalers who found that they could get a full load of oil in two or three months, instead of the three to five years required for a sperm whaling voyage. Soon there were dozens of whaling vessels working the lagoons of Baja California, as well as a dozen shore whaling stations along the coast of California that intercepted the migrating whales. This heavy exploitation rapidly depleted the gray whale stocks. By the year 1900, the once-abundant gray whale stocks were almost extinct, and the last whaling station closed.

The few surviving gray whales were left in peace for a few years, and their numbers presumably began to increase slowly. Soon, however, a new threat to their survival appeared, for in 1905 the first modern-style whaling station was established on the west coast in British Columbia. Using steam-powered catcher boats equipped with harpoon guns, this new breed of whaler was far more efficient than the old-fashioned whalers who used open boats and hand harpoons. Other stations soon sprung up in California, Washington, and Alaska. Fortunately for the gray whales, these modern catcher boats were fast enough to hunt the larger and more profitable rorquals — the blue, fin, and humpback whales — which had been too swift for the 19th century whalers to attack, and which were thus still common during the summer months. Therefore, the whalers made little effort to pursue the smaller gray whales which, furthermore, could be found only during the winter, when the weather was often rough.

Another innovation in whaling soon appeared — the floating factory ship which enabled whalers to shift operations to any area in which they found whales. Inevitably, expeditions consisting of a factory ship and a fleet of catcher-boats attacked the gray whales on their winter grounds and in the calving lagoons in Mexico — first in the winter of 1913-14, and again from 1924-25 to 1928-29. These whalers discovered large numbers of blue and humpback whales along the Mexican coast, so they turned their attention away from the gray whales. The size of the world catches up to 1947 suggest that the gray whale population was well on the road to recovery, and the catches apparently were not large enough to reduce the population.

In 1947, seventeen nations ratified the International Convention for the Regulation of Whaling. This convention forbids the killing of gray whales, except by aborigines, or by contracting governments when the meat and other products are to be used solely for local consumption by aborigines. Under these terms, small numbers of gray whales are killed annually in Siberia, and a few in Alaska.

Under the protection afforded by the international treaty for the past 23 years, the gray whale population has increased substantially. In 1970, we estimated the population to be about 11,000. We have also learned many hitherto unknown details of the gray whale's life history and ecology by examining animals collected under special scientific permits. Sufficient data is probably now available to regulate exploitation on a rational basis if the International Whaling Commission were to permit a resumption of commercial whaling for the species. Despite their potential commercial value, gray whales are probably more valuable as an asthetic resource to be enjoyed by the thousands of people who go to our west coast each year to watch the migration, and as a scientific resource that may enable biologists to solve many of the puzzles of diving physiology.

Unfortunately, scientific knowledge and international regulation of whaling may not be sufficient to ensure the ultimate survival of the gray whale. As the world's human population grows, the whale's few calving lagoons in Mexico will surely become more industrialized and polluted. Eventually, like San Diego Bay, they may no longer be habitable for the gray whale.

INDIAN WHALING

Harold L. Amoss

Indians living along the rugged coast of North America from the mouth of the Columbia River to Yakutat Bay in Alaska had a highly developed culture, based upon an abundance of food from the sea. Even though the whale was an important element in the mythology and art style of most Northwest Coast Indians, it was only hunted by five groups: Nootka, Makah, Quileute, Quinault, and Klallam. Archaeological evidence from the Ozette Dig indicates that whale hunting has had a long tradition among the Makah on the northwest tip of the Olympic Peninsula.

Although seven species of whale — gray, sperm, right, humpback, finback, sulphur-bottom, and killer — were recognized and named by the Makah, the gray whale was the preferred target.

Hunting for Northwest Coast Indians was not merely a matter of technical skill. Success was dependent upon supernatural assistance; therefore ritual behavior, both before and after a hunt of any animal, was essential. Because the whale was the hunter's most challenging quarry, ritual behavior associated with whale killing was most elaborate. One of the necessary preparations was ritual bathing in a freshwater lake or pond. At the bathing place, the hunter imitated the whale, demonstrating what he would like the whale to do. Prayers were offered and assistance was sought from the dead by using human skeletons or skulls or corpses during the ceremonial bathing. Sexual intercourse was forbidden before the hunt, and special dress was worn.

In addition to the most important religious preparations, Indian whale hunters checked over vital equipment, and members of the canoe team practiced. The leader of the hunt, the harpooner, was always a person of high rank. Hunting techniques and ritual secrets were jealously guarded, so that only a few persons were wealthy and knowledgeable enough to lead a whale hunt. Accounts of Northwest Indian whaling do not indicate whether the other seven members of the crew were also of high rank, but very often a second boat, captained by a relative of the leader, was allowed to strike the wounded whale after the first harpoon had been thrust.

A whale sighted on the surface was approached quietly in an effort to surprise it. If the whale dived, the hunters calculated the place where it would probably come up again, and would try to position the canoe close to the surfacing whale. The harpoon was thrust, not thrown, from immediately beside the animal's left side. As soon as the whale was struck, it thrashed its tail in an attempt to sound. The canoe was in great danger at this point, and skillful handling of the paddles was required to move it away from the whale's side. As the wounded mammal retreated into the depths, the line from the harpoon paid out from the canoe, taking with it a number of floats that marked the whale's flight, and exhausting it by frustrating its efforts to submerge.

Eventually, the exhausted whale came to the surface for the last time. The hunters, who had followed the floats, then killed it with a pointed lance, after first rendering the animal helpless by severing the main tendons which connect its muscles to its flukes. Its mouth was tied to prevent sinking, and the carcass was finally towed back to the beach near the village.

If the hunter or his crew made a mistake, or if the wounded whale headed out to sea instead of landward, the misfortune was ascribed to a mistake in the rituals preceding the hunt.

The whole village came to the beach to welcome the whale, for the whale was believed to have cooperated in its own death. The whaler's wife danced and sang. Menstruant women, on the other hand, were not supposed to see the whale, because they would spoil future whaling luck. The animal was carved under the supervision of the harpooner, and the meat apportioned according to traditional formulas. Special portions were given to the crew and the remainder to members of the tribe. The blubber was rendered into oil, while the best pieces of meat were eaten immediately. The bones were not used.

Formerly, there were two principal canoe types among Northwest Coast Indians, a northern and a southern. The northern canoes, perhaps best made among the Haida, were hewn from a single tree up to 60 feet long, with a rounded bottom and a characteristic bow and stern. The southern dugout canoe was somewhat smaller and had a different shape. It was, however,

"The whaler — Makah" — 1915 photo by Edward S. Curtis.

a seaworthy craft. In 1901 Captain J. C. Voss sailed such a vessel, a modified 38 foot Nootka canoe, from Vancouver, by devious routes, to England.

It took a great deal of courage to paddle these magnificent big dugout canoes, sometimes out of sight of land, in search of a whale. To approach close enough to a large whale to thrust a harpoon was always dangerous. The whale could smash a canoe with its flukes.

The Indian whaling equipment, the involved techniques, and the belief system that was centered on whaling all seem to be related to that of the Eskimo of the Bering Sea, suggesting contact between the Eskimo and the whaling Indians over a considerable length of time. The absence of the whaling complex among those Indian people (Tlingit, Haida, Tsimshian, and Kwakiutl) living between Nootka and Eskimo, suggests that they may have interrupted a route of communication by coming into the area at a later date.

It is not easy to understand why the Haida on the Queen Charlotte Islands, for example, did not pursue the whale. They apparently thought very little of paddling 80 to 100 miles across the treacherous Hecate Strait in order to reach the mainland. The Haida raided for slaves on the mainland as far south as the present boundary of the United States. They were fearless boatmen with large, sea-going canoes, but did not choose to hunt the whale. It was left to the Nootka, the Makah, and their close neighbors, the Quileute and Quinault, to develop whaling to its highest degree among the Indians of the Northwest Coast.

BALAENOPTERINE or FINNER WHALES

Edward D. Mitchell

Stories abound regarding the size, tenacity to life, speed, and near extinction of the beautiful big whales. However, the nature of the beast alone is so noteworthy that I recount the facts without embellishment.

Balaenopterid whales represent the most recently evolved and modern type whale now living. The blue whale, the largest, and the related but superficially different humpback whale are discussed separately. The remainder of the Balaenopterids comprise the second largest, fin whale *(Balaenoptera physalus);* and in order of decreasing size, the sei whale *(B. borealis);* Bryde's whale *(B. edeni)*; and the smallest of the lot, two species of living minke or little piked whales *(B. acutorostrata* and *B. bonaerensis).* Of these, the sei whale and the minke whale *(B. acutorostrata)* are the two most commonly found in the North Pacific, from California north to Alaska; Bryde's whales are tropical species. Only the sei, little piked, and fin whales of the North Pacific will be discussed.

Even whalers have difficulty in distinguishing between the species. Identification of these whales at sea is usually based upon a combination of physical characteristics — size and shape of the dorsal fin, its placement on the body, and the shape and color of the head — and behavioral features — including respiration rate and the whales' running pattern when chased. Generally, the fin whale has a dorsal fin that is more angular on its leading edge than that of the sei whale's, which is more smoothly curved and slightly higher, like a sickle or scimitar. The dorsal fin of the minke whale differs a little, having a broad base. The position of the fin on the body differs in all these species. The minke whale's dorsal fin is quite far forward on the body, and whenever the whale blows, the dorsal fin is immediately visible on the back as it breaks the surface of the water. The sei whale's dorsal fin is slightly farther aft on the body, compared to the minke whale's, and the fin whale's dorsal fin is even farther back. Generally, the larger the species of whale the smaller the dorsal fin, and the farther back on the body.

Therefore, if the size, shape, and color of head, fin, and back are known, whales can be identified at sea by noting the time interval between the appearance of the dorsal fin and the head, when the animal blows. Thus the minke whale's dorsal fin is evident immediately, very often the sei whale's dorsal breaks the water just after the blow, and in the fin whale the wheel-like silhouette of the whale shows the blow, then the back of the whale, and finally the dorsal fin. In the blue whale the appearance of the fin is much delayed — first the blow is seen, then the back of the animal, which often disappears beneath the surface, and finally a very small nubbin of a fin breaks the water just before the flukes lift slightly and the animal dives. These characteristics may differ a little, depending on the behavior of the whale at the time of sighting, and so cannot be taken as absolute. But with an estimate of the size of the whale, its pigmentation pattern, the environmental and zoogeographic context of the sighting, and the general behavioral pattern of the whale, a good, final identification can be made, even at a distance.

The sei whale is known to be a "skimmer", feeding near the surface. Its respiratory rate reflects this behavior because the blows are quite evenly spaced over long intervals. As a shallow diver and skimmer, the sei whale emerges from the water to blow at a shallower angle than the fin whale. Hence, the dorsal fin shows for a much longer time on the sea surface and the back is exposed over a longer distance.

The fin whale is reputed to dive to moderate and deep depths, and accordingly its respiratory rate will show unequal spacing. Three or four blows, equally spaced, will be followed by a hiatus of five to ten minutes as the animal dives and surfaces again. Thus even at great distances the blow rate or pattern of a large balaenopterine whale will aid in the identification of the species.

Of these species only the blue whale consistently lifts its flukes slightly when diving. This is often not visible at a distance, since the flukes do not come up vertically out of the water as they do with humpback, right, and sperm whales. Instead the flukes are elevated only a few inches above the surface, horizontally, while water spills off slowly. In deeper water the flukes lift slightly more.

Bryde's whales differ from sei whales mainly in their accessory head ridges. Two ridges run from near the snout tip back to beside the blowhole, alongside the median head ridge. Thus a whale with three ridges on its head is a Bryde's whale; with only one, it is one of the other species of *Balaenoptera.*

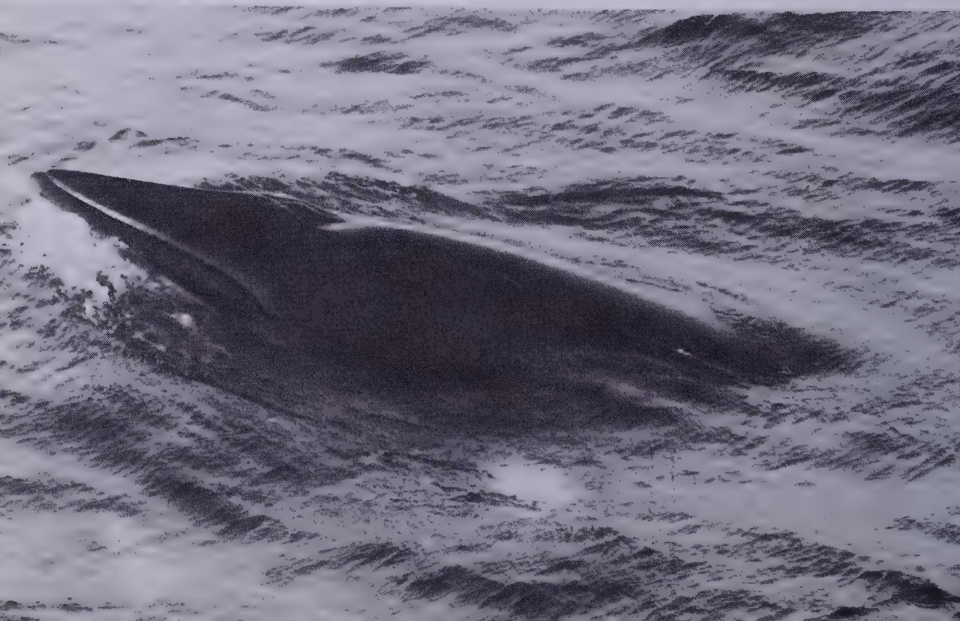
Minke whales are not so easily categorized. They have the habit of approaching ships and, because they are small and somewhat secretive, tend to be sighted only once or twice without a careful watch. The blowing pattern is not as regular or predictable as the sei or the fin whale's, but this may reflect the minke whale's response to an observer.

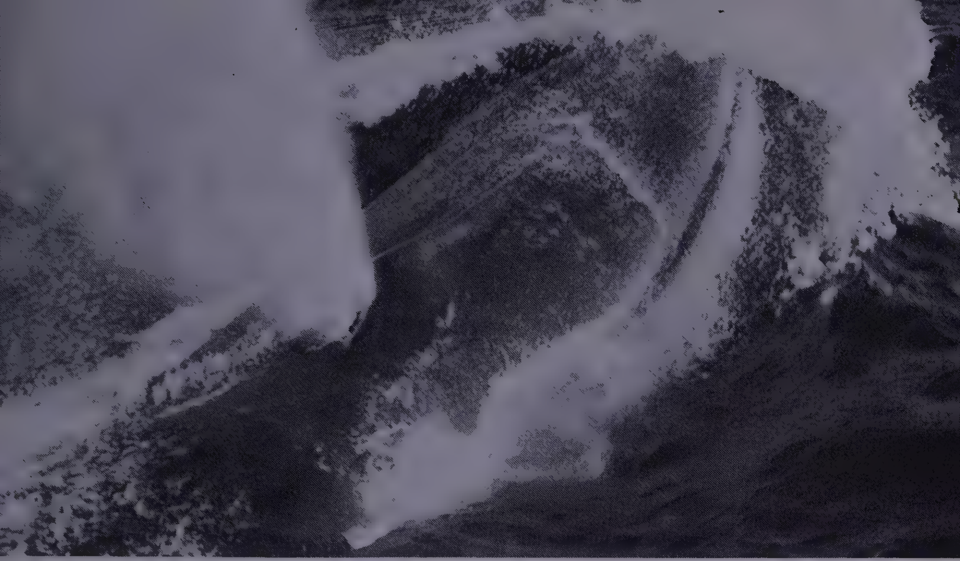
Minke whales have a distinct type of pigmentation — the major area of the body and trunk is dark, but the flippers have a white patch. These patches can be seen easily under water, and can identify this species.

Pigmentation affords the best means of identifying the fin whales — a chevron on the neck, and a lower jaw which is completely white on the right and dark on the left. By approaching whales on their right sides, identification can be confirmed by noting the white lower jaw.

Of these balaenopterine whales, the one most likely to engage in aerial acrobatics is the smallest — the minke whale — which leaps from the water in a clean breach, sometimes upside down. Frequently a splash at great distances at sea will turn out to be

A minke whale — sharp-headed little finner whale - shows its acute snout tip, darkened pigmentation, and white patch on the flipper, visible under water. Photo by author.





A fin whale, as it noses up and blows, shows its white, right lower jaw (visible under water), single head ridge, and long, wide, flat head. Photo by author.

a humpback or minke breaching. The breach of a minke differs from a humpback's — the latter usually comes part way out of the water and falls sideways, making a big splash; the minke arches more gracefully and its splash is smaller.

Unlike the California gray whale, whose strict migration route enters very shallow coastal waters, the fin whale is a more pelagic, open ocean animal with a less rigid migration. Although populations do occur off coasts, there are open sea populations in the middle of the North Pacific Ocean. All of these populations migrate north and south; hence, there is a limited gene flow between them — east to west and west to east. Two major stocks are presently recognized in the North Pacific.

In most of the world's oceans the blue whale migrates up to the edge of the ice — the case in the North Atlantic Ocean and in the Southern Hemisphere. But in the North Pacific this pattern appears to be reversed — the blue whale does not migrate far into the Bering Sea. The fin whale is found throughout the Bering Sea in the summer feeding season and many Russian and Japanese kill records are from this area.

The minke whale feeds predominantly on fish, but also on euphausiids and other invertebrates from time to time. The fin whale eats small fish when they are in concentrated groups, or euphausiids when they are plentiful. However, the blue whale is adapted to feed only on invertebrates, basically four species of euphausiids. The sei whale probably feeds mainly on even smaller invertebrate prey species, such as copepods. The baleen plates — the differences in length and texture of the bristles and the number of plates — reflect an apparent adaptive spread into a variety of niches throughout the evolution of these balaenopterine whales.

In general, one to three minke whales are sighted together at various places, both inshore and offshore. Fin whales usually congregate in groups of three to ten, or 20, and schools of many more animals are often sighted on the feeding grounds. Sei whales likewise congregate in the tens, and as with fin whales, are apt to be sighted in great numbers on feeding grounds.

Little is known of fin whale herding behavior or group composition during the reproductive season in the northern winter. Reproduction in the North Pacific fin whales is not completely understood, but they probably breed in the months of December and January, migrate north after giving birth to calves about 20 feet long, and feed in the northernmost reaches of the Pacific Ocean up to and including the Bering Sea. The return migration to more temperate waters occurs during October and November; and the cycle starts again. Any individual female fin whale may breed one year and suckle the next; there is at least one resting year — sometimes more — between pregnancies. The calves nurse for about six months and are weaned when they reach a length of 36-40 feet.

Sexual maturity is attained before physical maturity. Females of the Northern Hemisphere reach the following approximate lengths when sexually mature: minke, 22-24 feet; sei, 42-44 feet; fin, 62-63 feet; and blue, 72-74 feet. Females of these species reach greater lengths at or near physical maturity: minke, 27 feet; sei, 50 feet; fin, 67 feet; and blue, 87 feet. The maximum lengths attained are: minke, 32 feet; sei, 61 feet; fin, 80 feet; and blue, 98 feet. Females are slightly larger than males, but sexual dimorphism is not otherwise distinct.

Balaenopterine whales live for decades. Estimates of age are subject to various interpretations, and range upwards for some species, such as the fin.

Although the largest whales are obviously difficult to weigh, some figures are available: an 89 foot blue whale weighed 122 tons, and a 69 foot fin whale weighed 54 tons.

None of these whales are known to "sing" like the humpback whale. Their acoustic behavior is reputedly limited to the emission of very low frequency sounds — perhaps as low as 20 cycles per second — which may be propagated over great distances. These repetitive signals have been traced in many parts of the world, but the attribution of them to specific species of the balaenopterine whales is still being researched. There is evidence that higher frequency signals may be emitted by some of the Balaenopteridae. The inference is that these high frequency signals may be used in echolocation.

The eyesight of whales appears to be quite good, although their main sensory input from their environment is probably acoustic. Their sense of smell has been modified to some degree. The chemoreceptors responsible for taste and smell may be so specialized or modified as to not be fully recognized or known at the present time.

It has been said that the large whales are among the most intelligent of mammals, but apparently this is not true. Whalemen say they can be hunted much like the ungulates. Groups can be stampeded, and during the hunting maneuvers individual whales can be tricked into diving and turning in specific directions. The whaler takes advantage of these predictable reactions in order to place his ship near the whale when it surfaces.

Even though these large sleek whales appear very healthy, they carry a parasite burden comparable to land mammals. The most obvious is a parasitic copepod — the female burrows into the blubber of the whale, anchoring itself with three projections from the head region. These animals, called *Penella,* look like pieces of rope or string attached to the whale's skin, projecting about six to ten inches, and can easily be seen at sea on heavily infested animals from distances of a few tens of meters. Barnacles are sometimes found on the finner whales.

The sei whale, migrating to tropical waters in the northern winter, is especially prone to predation by lampreys. Seen at close range they often have small spots, one or two inches in diameter, particularly on their flanks. Some of these spots represent natural pigmentation splotching; others represent scars left by lampreys.

Many whales, especially the balaenopterines show green, yellow, or brown colored patches of diatoms on their appendages or bodies. These whales have usually just migrated from one region to another, particularly from the temperate to polar waters. Odd scars such as deep gouges, tooth marks, broken jaws, and mutilated fins, flippers, and flukes are fairly common in all whale tribes. Fin whales landed at whaling stations often show

A blue whale, photographed off Baja California, shows its mottled pigmentation and wide, broad, flat rostrum. Photo by K. C. Balcomb.

scars that may represent the bites of small sharks and killer whales.

The balaenopterine whales were exploited heavily from about 1890. Before this time a suitable technology had not been developed to capture these sleek, large, very fast, and powerful species. Likewise, the market for products had not changed from the earlier demand for sperm whale oil for illumination and whalebone for corset stays. With the drop in population numbers of the right whales, emphasis was placed upon the balaenopterines. After the blue whale, the fin whale was heavily exploited because it was the next largest animal. Now, with heavy catches of fin whales in the world's oceans, the emphasis has shifted to the smaller sei whales, currently being exploited at a high rate. The exploitation regime has moved down the size range; the smallest species are now being caught.

Population estimates, 1971, of some of these species in the North Pacific are: 1000-2500 or more of the now fully protected blue whale, 15,000 fin whales, 46,000 sei whales, and fewer minke whales.

At this time, Antarctic minke whales are being exploited. This is the first time that a species of whale has been studied, and quotas on both a species and a regional basis have been set, before exploitation has really begun. Quotas were 3000 for minke whales in the Antarctic in the 1971 season, and 5000 for the 1972 season. It remains to be seen how well this last *Balaenoptera* resource will be managed.

BLUE WHALE

Dale W. Rice

"Ballena! Ballena azul!" I had almost dozed off in the warm sun on the flying bridge of the whale-catcher, *Lynnann,* when Ernesto's cry from the crow's nest jerked me to attention. Three miles off our port beam, a thin jet of vapor rose from the water, drifted downwind and dissipated. Then I spotted two great blue-green shadows gliding under the gentle swells. In a moment, they broke and sent up two more plumes of vapor. Ernesto repeated his cry — "Blue whales! Two — maybe three!" With a quick sighting over the compass binnacle, I kicked out the "iron mike" that had been holding us on course and spun the wheel to port. The *Lynnann* heeled hard over in a tight turn — a maneuver which brought the rest of the crew scurrying up from the galley. There is no whaler and no whale biologist, no matter how experienced, who is so jaded that his heart does not race at the sight of a blue whale.

Fifteen minutes of hard steaming brought us close to the whales. Captain Bud Newton took the wheel for the stalk. I positioned myself on the gun platform on the bow, but the big 90-millimeter harpoon cannon remained unloaded and covered. I was armed instead with a 12-gauge shotgun that fired 10-inch, pointed stainless steel tubes, each inscribed with a number and the message "Notify U.S. Fish and Wildlife Service." The next time the whales surfaced and blew, the skipper put us on collision course with them. A few minutes later, I spotted one of them in the clear water just ahead of us. Powerful rhythmic strokes of its 16-foot wide flukes effortlessly propelled its streamlined bulk through the water. After an eternity, the huge flat head broke the surface and the animal blew with a loud "whoooosh" only 25 yards away. Braced on the pitching platform, I fired just as the whale arched its giant back to submerge. It did not even flinch as the mark buried itself into the back muscles — a mere mosquito-bite.

These blue whales which congregate off the coast of Baja California every year from February to June represent one of the last sizeable stocks of blue whales left on the earth. We do not know where they spend the remainder of the year; our reason for marking them was to trace their migration routes. If they should be killed on the whaling grounds farther north, the marks would be discovered in their flesh and we would be able to determine where they spent the summer. Unfortunately for science, but fortunately for the survival of the species, blue whale hunting was banned shortly after our marking program got under way, so their wanderings still remain a mystery. The marks should remain in them for life — which could be over 60 years — so the mystery may be solved decades hence, after the population has increased enough to justify whaling again.

At one time or another, blue whales have been found almost everywhere in the world's oceans, from the equator to 85 degrees north latitude in the Arctic Ocean north of Spitzbergen, and to 78 degrees south latitude in the Ross Sea of Antarctica. Their main summer feeding grounds, however, are restricted to relatively small areas of the most highly productive waters, most abundant in the circumpolar belt between the Antarctic pack and the Antarctic Convergence, which delimits the boundary between the cold Antarctic waters and the temperate waters at about 50 degrees to 60 degrees south latitude. A smaller variety called the pygmy blue whale inhabits the waters between 40 degrees and 55 degrees south latitude in the southern Indian Ocean, particularly around Marion Island, the Crozet Islands, and Kerguelen Island.

In the North Pacific, these giants range during the summer in the immediate offshore waters from central California and the northeastern coast of Hokkaido north to the Gulf of Alaska and the Aleutian chain. They rarely enter the Bering Sea, but have on occasion been observed as far north as the Chukchi Sea. In winter and spring, they congregate off the west coast of Baja California — where I have observed them most often — and at least formerly from southwestern Honshu to Taiwan on the Asiatic side. At this season, a few have also been sighted in mid-Pacific between 20 degrees and 35 degrees north latitude.

The blue whale *(Balaenoptera musculus)* is the largest of the rorquals, a family of baleen (whalebone) whales characterized by their pleated or corrugated throats. The six species of rorquals range in size down to the little minke whale *(Balaenoptera açutorostrata)* which is only 30 feet long. Aside from its great size, the blue whale may be distinguished by its blue-gray color, mottled with lighter gray; only the undersides of its flippers are white. The dorsal fin is small — little more than a step in the ridge of its back — and its tongue, palate, and baleen plates are inky black.

Although these are the largest animals that have ever lived, it is difficult to separate fact from fiction when you try to find out exactly how big they do get. After combing the literature and questioning whale biologists from all over the world, I find that the longest blue whale (measured in the standard zoological manner in a straight line from the tip of the snout to the notch between the tail flukes) that can be authenticated was a 98-foot female examined by Dr. Masaharu Nishiwaki of the Japanese Whales Research Institute in the Antarctic in the 1946-47 season. The heaviest blue whale on record is an 89-foot female that was cut up and weighed piece by piece aboard a Japanese floating factory ship in the Antarctic in January 1948 — she weighed 285,600 pounds. Allowing for a 12 percent loss of blood and body fluids, she must have weighed about 320,000 pounds when alive. The largest blue whale that I have examined in the North Pacific was an 82-foot female killed off San Francisco in September 1959. This animal weighed 181,200 pounds and must have weighed about 203,000 pounds in life. She yielded 52,500 pounds of meat.

Blue whales become sexually mature when about ten years old. From that age onward, each female gives birth to a calf once every two or three years. The mating season extends over about five months in the late fall and winter, and the gestation period lasts about a year. Since the annual cycles of Southern Hemisphere and Northern Hemisphere blue whales are six months out-of-phase, they cannot interbreed.

At birth the blue whale calf is about 23 feet long and weighs about 5500 pounds. During the nursing period, its mother must supply over 50 gallons of milk a day. This milk contains 35 to 50 percent fat and enables the calf to gain weight at the prodigious rate of over 200 pounds a day, or some nine pounds per hour. By the time it is weaned at the age of seven months, the calf is 52 feet long and weighs 50,000 pounds.

Of all the large whales, blue whales are the most particular about their diet. They are not known to feed on anything other than certain species of "krill" — small shrimp — like crustaceans belonging to the family *Euphausiidae.* The particular species they eat varies from one part of the world to another. In the Antarctic Ocean, it is *Euphausia superba,* a "giant" species that reaches a length of over two inches. Off California and in other parts of the North Pacific, the main species is *Euphausia pacifica,* which is less than an inch long; of secondary importance is a slightly larger species called *Thysanoessa spinifera.* In whatever part of the world, the species of krill selected by the blue whale all have two characteristics in common: they congregate in large, dense shoals, and they live fairly close to the surface. The only possible exception to this exclusive diet of euphausiids is off Baja California; I have observed blue whales there that appeared to be feeding on "red crabs" *(Pleuronocodes planipes)* which look like tiny lobsters and — like the euphausiids — often gather in immense shoals at the surface.

An average blue whale weighing 75 or 80 tons probably requires about 1.5 million calories a day. Since it fasts for much of the winter, it must consume about twice this amount — or three million calories a day — during the summer months. One pound of *Euphausia pacifica* supplies about 400 calories. This means that it must consume about four tons of krill every day. Its stomach holds about a ton, so it eats four *full* meals a day. Each individual of *Euphausia pacifica* weighs only one-tenth of a gram, so it takes about 40 million of these krill to sustain one blue whale for one day.

To obtain this immense quantity of food, a blue whale must filter thousands of cubic yards of water through the sieve-like series of baleen plates — about 325 on each side — which grow in its upper jaw. Most species of baleen whales fall into two groups on the basis of their feeding behavior: the "skimmers" — such as the right whale and the sei whale — that swim along with their mouths wide open, and the "gulpers" such as the blue whale. When a blue whale encounters a shoal of krill, it rolls on its side, presumably to allow more maneuverability in the horizontal plane. Its huge U-shaped lower mandible hangs open about 50 degrees and its pleated throat balloons out. Slowly it engulfs a mass of krill, closes its mouth and, by tightening its throat muscles, sends the water streaming out between its baleen plates, leaving the krill trapped on the fibrous fringes of the inner edges of the baleen plates. Its huge fleshy tongue then scrapes the krill back to the gullet. The whale repeats this process hour after hour, day after day.

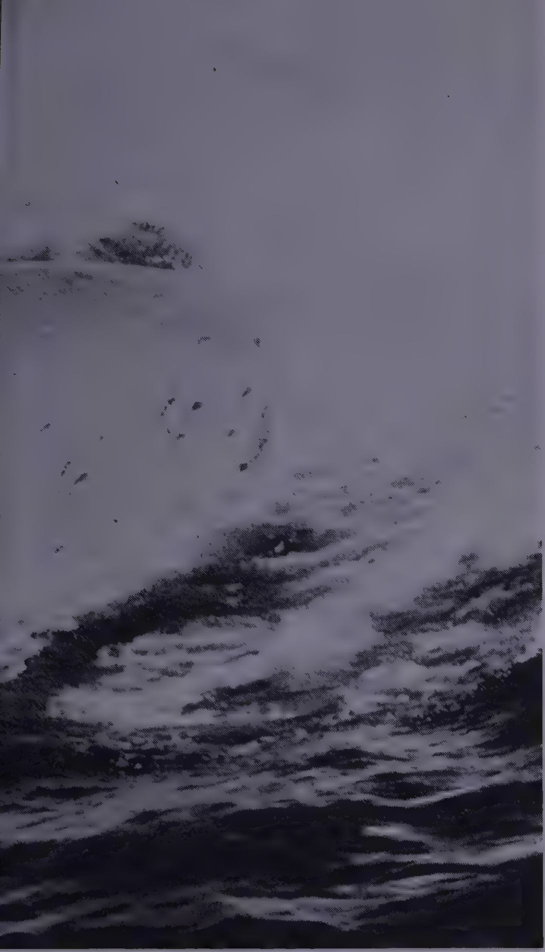
Probably because of their fastidious diets, blue whales are much less prone to infestations of parasitic worms than are other species of baleen whales. In their stomachs, I have never found the herring-worms *(Anisakis simplex)* which other species of baleen whales often harbor in great numbers — apparently picked up by eating fishes infested with the immature stages. About half the blue whales taken off California carried thorny-headed worms *(Bolbosoma nipponicum)* attached to the lining of their small intestine. The only other internal parasite I have found was a giant kidney worm *(Crassicauda crassicauda)* in about one quarter of the animals examined.

Blue whales do not usually carry many ectoparasites either. The few they do have are among some of the most peculiar creatures in the animal kingdom. *Penella* is a crustacean of the Order *Copepoda* — so highly specialized that at first glance it is not even recognizable as an animal. It grows anchored in the whale's blubber by a three-pronged tripod-shaped "root", between the "legs" of which is the rounded head; the stem-like "neck", which is several inches long, protrudes from the whale's skin and is terminated by a thickened "trunk" which bears a fringe of gill filaments and two long thread-like ovipositors. The male — rarely seen by zoologists — is a tiny creature that looks more like a normal crustacean. Another unique ectoparasite is a barnacle called *Xenobalanus globicipitis*. Although a true sessile barnacle, it looks more like one of the stalked or goose-neck barnacles, because the shell is reduced to a small star-shaped structure. Most of its body — which may be over two inches long — protrudes from the shell; it is long and cone-shaped with a turned-down "collar" through which its cirri, or legs, are protruded. This barnacle selects as its habitat the trailing edge of the tail flukes and occasionally the tips of the flippers or dorsal fin. On one whale, I found several hundred forming a solid rank along the hind margin of the flukes. In such a position, they must withstand a terrific water velocity when the whale is swimming fast. The barnacles are not true parasites, but filter their own food from the water flowing past the whale. Blue whales rarely carry "whale-lice" (really amphipod crustaceans) of a species *(Cyamus balaenopterae)* that also occurs on other species of rorquals.

Just as the barnacles "ride" the whale in order to take ad-

vantage of the food-carrying water currents, other fellow travelers have adapted themselves to exploit the tremendous volume of water that flows between the baleen plates. *Balaenophilus unisetus* is an almost microscopic copepod crustacean that lives in such uncountable millions on the baleen plates as to form a whitish scum. "Big fleas have little fleas . . ." and so *Balaenophilus* carries on its body and legs many jug-shaped ciliate protozoans belonging to a still-undescribed genus. Another denizen of the baleen plates is a tiny roundworm called *Odontobius ceti.*

One of the most interesting creatures that makes the blue whale its home is the whalesucker *(Remora australis),* a fish related to the more familiar sharksucker. This fish has been found only on cetaceans of several species — both large and small — but shows a decided preference for blue whales. I have seen dozens clinging to the sides of a blue whale. Like many of the blue whale's coterie of hangers-on, the whalesuckers are simply going along for the ride and catch their own food en route



Hitch-hiking whalesuckers and lampreys ride a blue whale's back as it broaches for a breath in the Pacific. Photo by author.

— a biological relationship called phoresy. One fish, however, is not such a harmless hitch-hiker. This is the Pacific lamprey *(Entosphenus tridentatus),* which uses its sucker-like mouth and sharp teeth to bite into the whale's skin, where it leaves characteristic scars.

Blue whales were too swift and powerful for the 19th century whalers to pursue with their open boats and hand harpoons. In 1864, the Norwegian whaler, Sven Foyn, invented the harpoon gun, and by the early 1900s blue whales, because of their large size, were the most sought-after target of whalers the world over. By 1966, the species was so scarce that it formed an insignificant portion of the world's whale catch, and the International Whaling Commission belatedly afforded the blue whale complete protection the world over. The original blue whale population in the 1900s probably numbered over 200,000. Today there are 15,000 in the Southern Hemisphere, 1500 in the North Pacific, and a few hundred in the North Atlantic.

HUMPBACK WHALE

Allen A. Wolman

One of the better known large whales is the humpback whale’ *(Megaptera novaeangliae).* It is easily recognized by its distinctive physical features and behavior, and because of its coastal migratory pattern, it is viewed by more people than most of the other whales. Humpbacks frequently breach, leaping clear of the water and partially spinning as they fall back with a resounding smack. They like to roll on the surface, slapping the water with their flukes and wing-shaped flippers. They swim on their backs for short periods, and sometimes turn somersaults under and above the water.

There are reports of attempted assistance by both sexes of humpbacks for wounded companions, such as supporting them under the water’s surface.

Courtship consists in part of stroking the partner with the entire body and flippers as one animal glides past the other, similar to that of the bottlenose and pilot whales. Humpbacks also give their partners playful slaps with their long flippers, resulting in smacks heard miles away, according to Captain Charles M. Scammon.

The humpback whale shares the family *Balaenopteridae* with the rorquals, which also includes the blue whale. *Balaenopteridae* and two other families comprise the Order *Mysticeti,* made up of all baleen whales. Humpbacks grow to about 51 feet, are relatively short, rotund, and have exceptionally long characteristic flippers. The flippers, one-fourth to one-third the total body length, are knobbed on the anterior edges. Fluke span is one-third of the body length. The body is dark colored dorsally with lighter skin ventrally, varying with the individual. The short, thick dorsal fin grows from the posterior third of the body. North Pacific humpbacks have 12-26 “grooves” (or pleats) in the throat, reaching to the navel, or behind it. Wart-like, round protuberances, each containing one hair or hair sac, appear on the skin of the head, forward to the blowholes. The humpback's blow is pear-shaped and about six feet high, compared with 20 feet high for a blue whale and ten feet high for a gray whale.

Large barnacles are visible on the chin, on the anterior portion of the grooves, along the anterior edge of the flippers, and on the flukes. The baleen plates are about two and one-half feet long, compared to the minke's eight inches long, and the Greenland right whale's ten feet in length. They number 270-400 plates on either side of the mouth. The plates are relatively short and dark, varying from ash-black to brown, with fairly coarse gray-brown fringes.

The relative thickness of blubber in humpbacks is greater than in any other rorqual species, and second only to the blue whale in absolute thickness. The average thickness is about five inches and the yield is three to six tons of oil. Vestigial hip bones and femurs are found in humpback whales, as in some other species. Roy Chapman Andrews, a renowned naturalist, found elements of a tibia, tarsus, and metatarsus in one animal.

The average brain weight is 11 pounds — about the same as an elephant — compared with a recorded 19.6 pounds for a sperm whale, and an average of three pounds for a man. The humpback brain is about 0.02 percent of body weight compared with 0.007 percent for the blue whale, 0.225 percent for the bottlenose dolphin, and 1.93 percent for man. In general, the larger the animal, the smaller the ratio of brain to body weight.

This oceanic species comes inshore for breeding, and has well-defined migration patterns. Humpbacks are more segregated in self-contained populations than any other species of whale, with the possible exception of the gray whale. They are separated into North Atlantic, North Pacific, and Southern Ocean (regions of the Atlantic, Indian, and Pacific Oceans surrounding Antarctica) stocks, forming several populations in the Southern Ocean with little interchange between stocks.

Humpback whales are much scarcer in the Northern Hemisphere than in the Southern Hemisphere. Marking by the Japanese has shown migration patterns between the Aleutian Islands region of feeding and the breeding areas of western North Pacific warm waters. Independent populations may exist on both sides of the North Pacific and North Atlantic, with some overlap on the northern feeding grounds. Northward and southward migrations each take about two months, with five and one-half months on the feeding grounds and a little over one month on the breeding grounds; the gray whale takes double the time for its migration, and spends only about two to three months on the feeding grounds. The mean rate of travel during the humpback's migration is less than four knots.

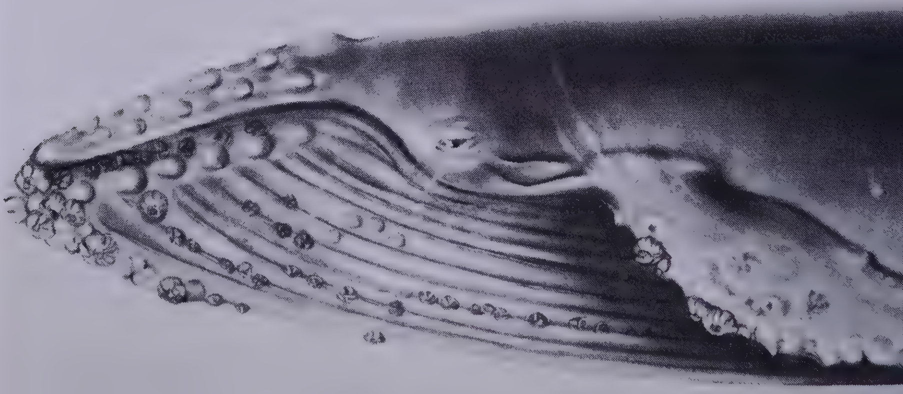
Eastern North Pacific humpbacks migrate from California and Mexican waters to the Bering Strait and Chukchi Sea. Northward migration begins in March and April, reaching Vancouver Island in May or June. Part of the population remains in the Aleutian Island area and off the coasts of Canada and Washington; others migrate around Alaska and through the Aleutians, reaching the Bering Strait and Chukchi Sea in July and August.

Although they feed mostly on euphausiids, humpbacks are known to occasionally eat large meals of fish such as anchovies, sardines, cod, and salmon. Stomachs of whales examined in coastal tropical or subtropical waters of both hemispheres in winter were almost always empty. The evidence indicates that humpback whales, like gray, blue, and fin whales, are seasonal feeders, obtaining nourishment in polar waters, and living on body fat reserves in the breeding season in warm waters.

Temporal segregation during migration to the breeding grounds has been shown. Females in late lactation take the lead, followed by immatures of both sexes, adult males, resting females, and pregnant females. The migration toward the feeding grounds consists of newly pregnant females and immatures, followed by mature males and females in early lactation. Thus, pregnant humpbacks arrive early and stay late on the feeding grounds.

Usually traveling in pods of two to five animals, they spout

Drawing by Evelyn Sczuck.



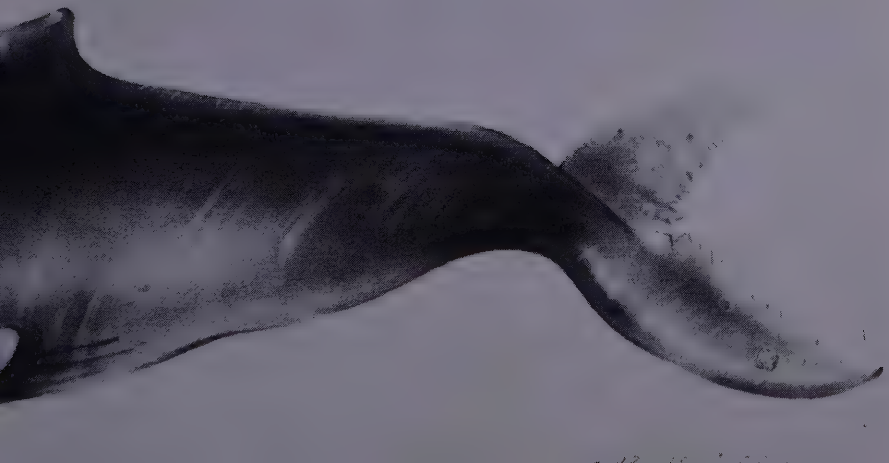
three to six times and then submerge for two to six minutes. They have been reported following moving ships for a long while. Once in the late 1880s, the same group of whales followed a ship from Cape Horn to Liverpool!

Vocalization ability is outstanding, with a rich, varied "vocabulary" and a wide range through the scale. The humpback's "song", a long series of varied phrases, repeated in sequence over intervals of more than a half hour, has been the subject of scientific studies. It was recorded and played at the 1970 World's Fair in Japan, and incorporated into a "concerto for whale and orchestra" by an American composer.

Many of the round scars on the skin of the humpback whale are caused by lampreys *(Entosphenus tridentatus).* Whales are also heavily infested by commensal barnacles *(Coronula diadema, C. reginae),* and the stalked barnacle *(Conchoderma auritum)* completes the impressive display by growing on the other barnacles. Two species of parasitic amphipod crustaceans called "whale lice" make their home on the skin among the barnacles, and a parasitic copepod *(Penella balaenoptera)* is sometimes found attached to the skin. Endoparasites abound, with nematodes in the stomach, kidneys, and ureter, and acanthocephalans in the intestine, but these infestations are rarely debilitating.

Sexual maturity of North Pacific humpbacks is attained at the age of six to 12 years; the length of the adult male reaches 38 feet, and the female, 39 feet. A whale from Puget Sound, about 50 feet long, weighed 35 tons.

This rorqual is known to resort to tropical coastal waters in the breeding season. The warmer water should benefit the calves because they lose more body heat than the adults. The



routes of their migrations have been demonstrated to a great extent by marking and direct observations.

The gestation period is 12 months. The average interval between conceptions is about two years, lactation lasting 11 months, some of which is probably protracted weaning. The percentage of twins conceived is 0.39 of total pregnancies, corresponding to 1.3 percent in man. Cows in the Southern Hemisphere have about 15 offspring during their lifetime. Females bear a calf every two to three years (rarely two years in succession).

The mating and calving season occurs during October to March, when the animals congregate in the warmer coastal waters. Newborn calves measure up to 16 feet and weigh about two tons, or five to six percent of the mother's weight.

The southern whale fishery, including humpback whales, began during the late 18th century and continued until the 1920s. All of this was open boat whaling under oars or sail, mostly with hand harpoons, pursuing the slow swimming species that usually floated when dead.

Catches in the Northern Hemisphere have always been much smaller than in the Southern Hemisphere, commensurate with size of population. Over 90 percent of the world catch in recent decades has been in the Southern Hemisphere. Annual world catches have depleted the population to a level which will take as long as 50 years to recover, even if under complete protection.

The minimum legal catch lengths would not have an effect on breeding stocks because humpback females, as all other baleen whales, grow to a longer length than males. Because of their migratory pattern, they are exposed to hunting at both ends of the migration routes. Similar to the gray whale, the humpbacks are slower and more gregarious than most other baleen whales, enabling whole groups to be taken at one time.

From 1963 the catching of humpback whales has been banned in the whole Southern Hemisphere; from 1966 to the present, they have enjoyed worldwide protection. Before exploitation, humpback whale stocks probably numbered 40,000 to 50,000 in the Southern Hemisphere, with lesser numbers in the North Pacific and North Atlantic. The present world population is about 5000; probably fewer than 2000 remaining in the North Pacific from the original stock of about 4000 whales. Since 1965, sightings have suggested little or no change in the number of whales, and it appears that recovery will be extremely slow.

BIBLIOGRAPHY

BODFISH, HARTSON H. 1936. Chasing the bowhead. Cambridge, Harvard University Press. 281 pp.

BROWER, CHARLES D. 1942. Fifty years below zero. New York, Dodd, Mead & Co. 310 pp.

GAMBELL, R. 1968. Seasonal cycles and reproduction in sei whales of the southern hemisphere. Discovery Reports, 35: 31-134.

HERSHKOVITZ, PHILIP. 1966. Catalog of living whales. U.S. National Museum Bulletin 246. Washington, D.C., Smithsonian Institution. 259 pp.

MACKINTOSH, N. A. 1965. The stocks of whales. London, Fishing News (Books) Ltd. 232 pp.

MATTHEWS, L. H. 1937. The humpback whale, *Megaptera nodosa.* Discovery Reports, 17: 7-92.

NISHIWAKI, M. 1959. Humpback whales in Ryukyuan waters. Scientific Reports of the Whales Research Institute, 14: 49-87.

OHSUMI, S. MASAKI, Y., and KAWAMURA, A. 1970. Stock of the Antarctic minke whale. Scientific Reports of the Whales Research Institute, Tokyo, pp. 75-126.

OMURA, H. 1966. Bryde's whale in the northwest Pacific. pp. 70-78. In: Norris, Kenneth S., editor. Whales, dolphins and porpoises. Berkeley, University of California Press. 789 pp.

RICE, DALE W. and WOLMAN, ALLEN A. 1971. The life history and ecology of the gray whale *(Eschrichtius robustus)* U.S. Fish & Wildlife Service. Special Publication No. 3, The American Society of Mammalogists. 142 pp.

SCAMMON, CHARLES M. 1874. Marine mammals of the northwestern coast of North America; together with an account of the American whale-fishery. San Francisco, John H. Carmany & Co. Reprinted 1968 in paperback. New York, Dover Publishers. 319 pp.

SLIJPER, EVERHARD J. 1962. Whales. Translated by A. J. Pomerans. New York, Basic Books. 475 pp.

SMALL, GEORGE L. 1971. The blue whale. New York, Columbia University Press. 248 pp.

TOMILIN, A. G. 1957. Mammals of the U.S.S.R. and adjacent countries. Cetacea, vol. 9. Moscow, Akad. Nauk SSSR. 756 pp. Translated by the Israel Program for Scientific Translations, Jerusalem, 1967. 717 pp.

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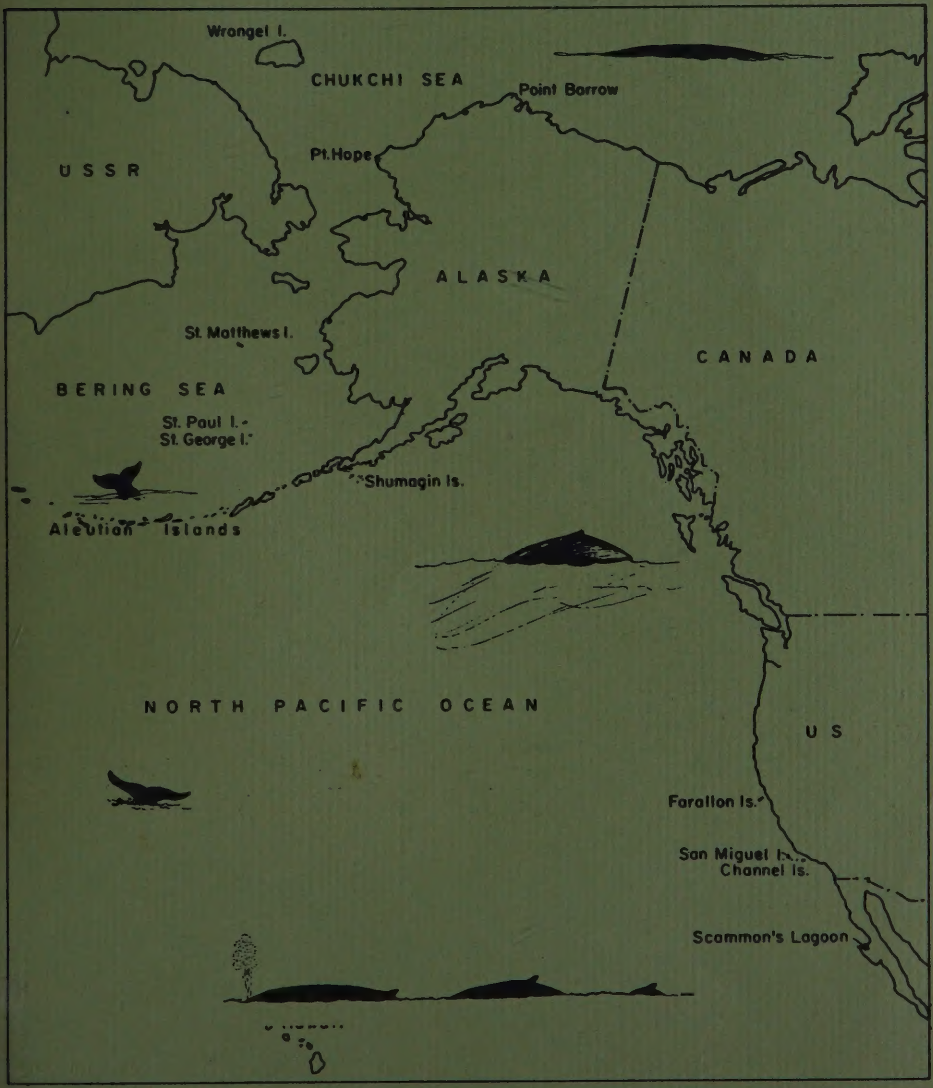

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